EXHIBIT D

Cost of Child Lead Poisoning to Taxpayers in Mahoning County, Ohio

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SYNOPSIS

Lead poisoning in children imposes both immediate and long-term financial burdens on taxpayers. The District Board of Health of Mahoning County, Ohio, quantified some of the direct costs to taxpayers of providing medical care and public health services to the 279 children diagnosed with lead poisoning in the county in 2002, using methods described by Katrina Korfmacher at the University of Rochester. The Board of Health also attempted to quantify the longer-term costs of special education and juvenile justice services attributable to lead exposure. The realization that lead poisoning costs local government on the order of $0.5 million each year has mobilized community leaders in education and juvenile justice to demand more aggressive action against rental property owners who fail to remediate lead hazards.

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Lead poisoning in children imposes both immediate and long-term financial burdens on taxpayers. The District Board of Health of Mahoning County in northeastern Ohio attempted to quantify some of the direct costs to taxpayers of providing medical care and public health services to the 279 children diagnosed with lead poisoning in the county in 2002, using methods described by Katrina Korfmacher at the University of Rochester.[1] Mahoning County, which includes Youngstown and surrounding communities, had an estimated 252,800 residents in 2002.[2]

The Board of Health also attempted to quantify the longer-term costs of special education and juvenile delinquency services attributable to lead exposure. These costs do not account for all of the direct and indirect costs that unremediated lead hazards impose on taxpayers, including the lost tax revenue from the lower wages of workers with intellectual deficits due to lead poisoning, or long-term health effects such as hypertension, osteoporosis, and dental caries in adults exposed to lead as children. Others have estimated the annual costs to society of lead poisoning in American children at $43.4 billion.[3] By comparison, estimated 2000 health costs due to motor vehicle accidents were just over $32 billion per year for the entire U.S. population.[4]

HEALTH CARE EXPENDITURES

The direct health care costs of lead poisoning include the cost of screening, treatment, and follow-up of severely and moderately poisoned children. Direct costs also include the cost of repeat blood testing and environmental investigation in these children's homes. As the U.S. General Accounting Office has pointed out, most of these health care costs for lead-poisoned children are paid by Medicaid, a state and federally funded health insurance program for low-income families.[5] Table 1 presents our most conservative estimate of direct health care costs borne by taxpayers for the 279 Mahoning County children with elevated blood lead reported to the Board of Health in 2002. For this analysis, elevated blood lead was defined as a blood lead concentration ≥10 micrograms per deciliter (μg/dl); 10 μg/dl is the Centers for Disease Control and Prevention's (CDC's) level of concern for blood lead.[6] Table 1 also takes into account screening costs for the 2,498 children with blood lead <10 μg/dl. (These children may have medical costs related to their lead exposure that are not included in the analyses reported here.)

Table 1. Estimated cost to screen and treat children for lead poisoning, Mahoning County, Ohio, 2002

Blood lead level	*Number of children*	*Estimated per-child cost to screen and treat*	*Estimated total cost*
<10 μg/dl	2,498	$29	$73,102
10–19 μg/dl	232	$69	$6,008
20–45 μg/dl	47	$969	$45,543
Total	2,777	—	$124,653

For the per-child costs we used Kemper et al.'s cost estimates,[7] inflated 123.8% from 1996 costs based on the medical care Consumer Price Index.[8] We included costs for all children listed in the Mahoning County STELLAR database as having received initial blood lead testing in 2002. (STELLAR is an acronym for Systematic Tracking of Elevated Lead Levels and Remediation, a lead poisoning management database developed by the CDC and adapted by the Ohio Department of Health for use statewide.) The majority of children tested had reported blood lead levels <10 μg/dl. We attributed only the actual test cost to these children. For children with higher lead levels, we included costs for medical evaluation, follow-up, and—for the highest levels (25 μg/dl)—medical treatment. Korfmacher cautions that costs calculated by this method underestimate current direct medical costs because behavioral and learning problems related to lead poisoning but not directly associated with treatment of lead poisoning may result in additional visits to health care providers. On the other hand, she also observes that because some children do not receive all recommended services or testing following initial screening, the actual community costs incurred for testing and follow-up may be somewhat lower than those reflected in Table 1.

SPECIAL EDUCATION EXPENDITURES

Long-term studies of children exposed to lead early in life have associated lead poisoning with lower class standing in high school, greater absenteeism, lower vocabulary and grammatical-reasoning scores, and poorer hand-eye coordination relative to other children.[9] This impaired neurobehavioral function accounts for many lead-poisoned children requiring special education services. Schwarz has estimated that 20% of children with blood lead levels >25 μg/dl will need special education (assistance from reading teacher, psychologist, or other specialist) for an average of three years.[10] In 2003, the average annual cost of special education was $18,000 per pupil in the city of Youngstown (compared with $7,700 per pupil overall), according to the superintendent of the Youngstown City School District (Personal communication, Ben McGee, January 2, 2004). Table 2 presents our estimate of special education costs for 20% of the 25 Mahoning County children with blood lead levels >25 μg/dl reported in 2002 as well as 20% of the estimated 54 children with blood lead >25 μg/dl not detected by screening programs. To estimate this latter number, we obtained from the local STELLAR database the percentage of children aged 12–71 months in calendar year 2002 whose maximum venous blood lead levels recorded were >25 μg/dl: 1.0% of children aged 12-71 months.

Since the majority of these children in the database resided in the city of Youngstown, we applied this percentage to the 2000 Census population ages 12–71 months of Youngstown.[11] For the remaining county population, we used the 2001 National Health and Nutrition Examination Survey (NHANES) estimate[12] that 0.3% of children <72 months had blood lead concentrations >25 μg/dl and reduced this number by 33% to reflect the secular decline in high blood levels that has likely occurred since the NHANES data were collected as well as to compensate for our use of >25 μg/dl

Table 2. Estimated cost of special education services for children with blood lead levels >25 µg/dl, Mahoning County, Ohio, 2002

Additional special education cost per child per year	$10,330
Estimated number of children ages 12–71 months with blood lead >25 µg/dl in 2002	79
Estimated number of children needing special education services[a]	16
Total cost per year of needed services	$164,800
Discounted cost per year	$142,158
Discounted cost for three years of special education services	$426,474
Discounted cost for each one-year cohort of children	$85,295

[a]20% of children with blood lead >25 µg/dl

(for consistency with Schwarz[10]) in contrast to the NHANES cutoff of ≥25 µg/dl.

These special education costs have been discounted at a 3% rate for five years on the assumption that they are incurred an average of five years in the future. The discounting for special education and juvenile justice costs (see below) was based on a "discount factor"[13] calculated as the inverse of $(1+\text{discount rate})^{\text{number of years}}$ which for educational costs (based on a 3% discount rate) was the inverse of $(1.03)^5$ or 0.8626. The annual special education cost of $164,800 was discounted by 0.8626, leading to the figure of $142,158 shown in Table 2.

Since the 16 children requiring special education would need an average of three years of service, their lifetime special education cost is three times the discounted value shown in Table 2, or $426,474. This cost, however, applies to the entire five-year cohort of children ages 12 to 71 months, so that the cost for a one-year cohort is one-fifth of the total, or $85,295.

The special education costs in Table 2 are based only on the probability of a learning disability for children with blood lead >25 µg/dl. Since a child's ability to learn is impaired by lead exposure at levels far below 25, Table 2 likely underestimates the true cost of special education, although no long-term studies have yet been published on whether children with non-zero blood lead levels <25 µg/dl incur significantly more special education costs than non-lead-poisoned children.

JUVENILE JUSTICE EXPENDITURES

A recent study by Herbert Needleman at the University of Pittsburgh has made it possible to estimate the extent of lead's contribution to juvenile delinquency.[14] Needleman calculated an adjusted odds ratio of 4.0 (95% CI 1.4, 11.1) for having bone lead levels ≥25 ppm (measured by K-line X-ray fluorometry) for adolescents aged 12–18 who had been arrested and adjudicated as delinquent relative to non-adjudicated high school controls. There is no established standard for relating blood levels (which have a half-life of about 30 days and reflect very recent exposures) with bone levels, but we assumed for the analyses reported here that Mahoning County children with documented blood lead levels ≥10 µg/dl have neurological damage comparable to that experienced by the subjects of Needleman's study.

We used two estimates of the number of children 12–71 months of age in Mahoning County with blood lead levels ≥10 µg/dl in 2002 to quantify the population at risk for later delinquency. One estimate (490 children) was based on an assessment by the Environmental Working Group, which estimated conservatively that 44% of children with blood lead levels ≥10 µg/dl were "missed" in Mahoning County in 2002 because of incomplete screening.[15] We performed a separate analysis for Mahoning County based on 7,150 children in the 2002 age cohort of 12–71 months who had blood lead levels recorded in the local STELLAR database. Eleven percent of these children—most of whom lived in the city of Youngstown—had levels ≥10 µg/dl. Applying this fraction to the 5,940 children ages 12–71 months reported by the 2000 Census as residents of Youngstown,[11] we derived an estimate of 653 prevalent lead-poisoned children ages 12–71 months within the city with blood lead concentrations ≥10 µg/dl. For the remainder of the county population ages 12–71 months (9,775), we used the national NHANES rate of 2.2% to produce an estimate of 131 children, for a total county-wide estimate of 784 children.[12] While we believe that the higher of these two estimates is a more accurate prevalence measure, we chose conservatively to use the mean of the two estimates, 637 children, for the calculations that follow.

Applying Levin's formula for population attributable risk as outlined by Gordis[16] and the prevalence estimate of 637 children, we estimated a population attributable risk of 11% for lead poisoning among adjudicated delinquents. Levin's formula calculates population attributable risk from the odds ratio of the exposure in adjudicated vs. non-adjudicated children (in this case, 4.0 for elevated bone lead and delinquency) and the proportion of the population with the risk factor (in this case, blood lead levels ≥10 µg/dl: 637 of 15,715 children). Attributable risk is, strictly speaking, a measure of association rather than causation. Studies such as Needleman et al.'s that show a strong association between lead poisoning and delinquency do not establish with certainty that lead poisoning causes delinquent behavior, nor do they offer any guarantee that in the absence of lead hazards the risk of delinquency would be reduced by 11% (or at all). Nonetheless, based on the results of Needleman's multivariate analysis, it is reasonable to calculate a population attributable risk on the assumption that confounding by other social variables was reduced by multivariate analysis.

Table 3 presents our estimate of the future costs imposed on the juvenile justice system in Mahoning County for lead-poisoned children who were 12–71 months of age in 2002 using this value for attributable risk. We discounted juvenile justice costs[17] by 3% over 15 years using the discount factor formula cited earlier.[13] The 15-year period for discounting was chosen because juvenile justice costs are most commonly accrued in the 15–18 year age range (Personal communication, Keith M. Hanni, MA. Probation Officer, Mahoning County Court of Common Pleas Juvenile Court Division.

Table 3. Estimated cost of juvenile justice services for children with blood lead levels >25 μg/dl, Mahoning County, Ohio, 2002

2002 juvenile justice expenditures	$5,276,967
Fraction attributable to lead poisoning[a]	11%
Lead poisoning–attributable cost per year	$580,466
Discounted cost per year	$372,560
Discounted cost for three years of juvenile justice services	$1,117,680
Discounted cost for each one-year cohort of children	$223,536

[a]Lead poisoning defined as blood lead >25 μg/dl

May 2004), i.e., 12 to 15 years beyond the mean age of this study's cohort of 12- to 71-month-old children.

We do not currently have data about the length of time children remain involved with the juvenile justice system in Mahoning County, but county probation and intake officers report that serious cases remain open for at least three years. Consequently, as with special education, we assumed that these delinquent children would need an average of three years of intervention; thus, the total cost would be three times $372,560, or $1,117,680. This cost, however, applies to the entire five-year cohort of children aged 12–71 months, so—as with the special education costs—the cost for a one-year cohort is one-fifth of the total, or $223,536.

PUBLIC HEALTH EXPENDITURES

The state of Ohio funds local efforts in Mahoning County to educate residents about lead poisoning and prevent and respond to cases of childhood lead poisoning through targeted outreach to prenatal clinics, preschools, and elementary schools; lead awareness home visits; and abatement programs.

Funding provided to the Mahoning County District Board of Health in 2002 for these purposes totaled $66,000. Most of this public funding would no longer be necessary if lead poisoning were eliminated. In addition to these public health expenditures, the U.S. Department of Housing and Urban Development provides a significant amount of federal funding to Mahoning County to assist low-income homeowners and landlords in remediating lead hazards.

COMMUNITY IMPACT OF THIS ANALYSIS

Table 4 presents a summary of yearly costs to taxpayers of childhood lead poisoning in Mahoning County in 2002 based on Korfmacher's model.[1] We have calculated costs both for lead-poisoned children actually detected by screening and for those who remained undetected because of incomplete screening. Summing these costs provides the total 2002 and future costs for the cohort of lead-poisoned children (with blood lead ≥10 μg/dl) aged 12–71 months in 2002 ($1,610,154). However, this simple summation is problematic because medical and public health costs in Table 4 accrue yearly, whereas the special education and juvenile justice costs in Tables 2 and 3 are time-limited, delayed in onset, and occur over several years. To make these costs more strictly comparable, we chose to express educational and juvenile justice costs in Table 4 per one-year age cohort.

As we have stressed, these calculations almost certainly underestimate some costs and do not include other direct and indirect short- and long-term costs imposed on taxpayers and society by childhood lead poisoning. As Schwarz has noted, property owner concerns about the cost of lead hazard remediation must be balanced with the burdens placed on taxpayers by property owners' failure to remediate these hazards in the homes of children who become lead-poisoned.[10] While there is a very wide range of cost estimates for lead abatement, Needleman cites a 1991 CDC 30-year cost estimate of $33.7 billion to remediate 18.4 million housing units ($2,519 per unit in 2004 dollars).[18] A cost-benefit analysis suggests that under some assumptions, strict enforcement of housing ordinances can be significantly cost-saving.[19]

We have used these estimates to brief members of a local coalition of public and private organizations that serve children (the Mahoning County Family First Council); Youngstown City Council and Board of Education members; juvenile court officials; child welfare advocates; and others who have an interest in the problem of child lead poisoning in Mahoning County. Prompted by revelations about property owner noncompliance with lead abatement orders (300 rental property owners in Youngstown ignored abatement orders in 2003), the Family First Council obtained private foundation funds to convene a series of regulatory negotiation ("reg-neg") meetings with the local landlord and realtors associations; City Council and Board of Health members; local regulatory officials; and other stakeholders. Through the reg-neg process, the Family First Council hopes that these stakeholders will reach consensus on an action plan to eliminate lead poisoning from the community by 2010. Reports in the Youngstown news media about landlord noncompliance with abatement orders and the cost to taxpayers have also drawn the attention of federal agencies responsible for enforcement of lead hazard disclosure laws. Enforcement officials from the U.S. Environmental Protection Agency and Department of Housing and Urban Development have begun interviewing many of the rental property owners in Mahoning County who have not complied with orders to remediate lead hazards on their properties.

Table 4. Estimated costs to screen and treat children for lead poisoning, Mahoning County, Ohio, 2002, including projected future costs

Screening and treatment[a]	$124,653
Special education services[b,c]	$85,295
Juvenile justice services[b,c]	$223,536
Public health services for all screened children	$66,000
Total	$499,484

[a]Lead poisoning defined as blood lead ≥10 μg/dl
[b]Per one-year cohort of children
[c]Lead poisoning defined as blood lead >25 μg/dl

Our estimates of the burden on taxpayers from lead poisoning, however incomplete, have helped to mobilize key stakeholders in our local educational and juvenile justice communities to demand action on behalf of lead-poisoned children. Subsequent to the involvement of these key stakeholders, the mayor of Youngstown appointed a special prosecutor to pursue noncompliant landlords; we have also documented a 14% reduction from May 2003 to May 2004 in the number of rental properties with unremediated lead hazards, the most significant decline since the Board of Health began enforcing lead hazard reduction measures in 1995.

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